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DOCUMENT-IDENTIFIER: US 6133867 A

TITLE: Integrated air traffic management and collision avoidance system

DATE-ISSUED: October 17, 2000

INVENTOR-INFORMATION:

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APPL-NO: 09/ 221925 [PALM]
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PARENT-CASE:
This application claims benefit of Provisional application Ser. No. 60/070,311 filed Jan. 2, 1998.

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US-CL-ISSUED: 342/29; 342/36, 342/30, 342/49, 342/125, 342/357.09, 342/357.1
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FIELD-OF-SEARCH: 342/29, 342/30, 342/31, 342/32, 342/36, 342/40, 342/41, 342/46, 342/49, 342/115, 342/125, 342/135, 342/140, 342/357.09, 342/357.1

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

	PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
☐	H1410	January 1995	Hartley	364/148
☐	5825326	October 1998	Semler et al.	342/357
☐	5838562	November 1998	Gudat et al.	364/424.02

ART-UNIT: 362

PRIMARY-EXAMINER: Sotomayor; John B.

ABSTRACT:

A collision avoidance system utilizes a satellite navigational system to continuously determine object motion parameters relative to the earth's surface and exchanges this information with other objects. The system calculates collision potential with other objects that are stationary or in motion based on the exchange of the motion parameters. Evasive actions are calculated with congested space and altitude floor taken into account. The system determines collision potential between two or more objects or can utilize a single ground monitor to perform the collision potential calculations between all participating objects.

19 Claims, 10 Drawing figures

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L2: Entry 1 of 1 File: USPT Oct 17, 2000

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Detailed Description Text (9):
The voice unit 400 is connected to the CPU 600 by interface 401 (such as an RS 232, RS 422, ARINC 429, MIL-STD-1553 or comparable communications protocol, or a backplane and bus if rack mounted). The voice unit 400 receives command strings from the CPU 600 and produces audio responses in response to the specific CPU information. A commercially available unit will be used (such as Model V8600 manufactured 1994 by RC Systems, Inc., 1609 England Avenue, Everett, Wash. 98203).

Detailed Description Text (44):
At the reception of a remote evasive action command (3030), the instructions are passed to audio 400 (3080) and the auto-pilot (3090). The position beacon rate is automatically updated (3100) to increase beacon rate (if it was not already increased due to close proximity rules) to once per second.

Detailed Description Text (75):
If it is determined that a collision is not imminent (the object is already determined to be in the general vicinity via 3230), the remote object's coefficients are transformed to be relative to the local craft's axis (3262) and the spotting function is performed (3250). In the spotting function, the spotting flag for that object is checked (the spotting flag functions as a mute button for that remote object). If the spotting flag is set, the announce frequency count is checked. If the announce frequency count is zero, the remote object translated position data is passed to the audio 400 and the announce frequency count is reset to a predetermined value. It may be set equal to the distance of the remote object in miles. Hence the closer the object, the more often its position is announced. It may also be set to a default such as 60 so that it is not announced often. If the announce frequency count is non-zero, the count is decremented.

Detailed Description Text (156):
If the remote craft does not contain collision avoidance processing but contains beacon, command transfer, and audio/visual announce capability, the local craft performs evasive calculations for both craft and then transmits evasive instructions to the remote craft (3330). The remote craft receives the instructions (3030), and announces or displays the instructions (3080).

Detailed Description Text (159):
The present invention contains a table of standard evasive maneuver instructions for both the local and the remote craft allowing a single present invention to coordinate the evasive action of both aircraft. One standard local evasive maneuver instruction is sent to the local craft cockpit and one standard remote evasive maneuver instruction is optionally transmitted to the remote craft. Note that the remote craft could optionally contain only a receiver and audio equipment to report the instructions of the master craft. This would allow inexpensive equipment to be installed in some craft that would utilize the collision avoidance processing done by remote craft or even remote objects.

Detailed Description Text (184):
The audio (voice) generator unit means 400 receives the position data, warning message, and (if applicable) corrective action message fro the CPU 600 and generates the warning message to the cockpit or craft cabin. The audible message is preferably of the form:

CLAIMS:

1. A collision Avoidance System for preventing the collision of moveable craft relative to the earth's surface where there is a common referenced multi dimensional position and motion determining system in operation comprising:

position determining means in said movable craft for determining data parameters of position, velocity, acceleration and time of said craft relative to the Earth's surface;

CPU means in said craft coupled to said position determining means for continuously storing said data parameters at time spaced intervals and calculating 2.sup.nd order motion path coefficients for transmission in time spaced data packets and for storing craft identification indicia and for storing craft operating parameters and limitations;

digital transmission means coupled to said CPU means for transmitting said time spaced data packets containing the craft identification indicia, the unique message type identification, the motion path coefficients, and the time data in digital format to remote receiver means;

digital receiver means coupled to said CPU means for receiving and storing said time spaced data packets containing the identification indicia, the unique message type identification, motion path coefficients, and the time data in digital format from remote transmitter means;

said CPU means having programming instructions so as to be responsive to said data parameters for calculating collision potential between said aircraft and remote object using aircraft motion path data, and data received from remote transmitter means; and

Audio means coupled to said CPU means in said craft for notification to craft operator of collision potential and/or evasive maneuver instructions.

10. A collision Avoidance System for preventing the collision of moveable aircraft relative to the earth's surface where there is a Navstar GPS system in operation comprising:

GPS receiver means in movable aircraft for determining data parameters of position, velocity, acceleration, and time of said aircraft from the Global Positioning System;

CPU means in said aircraft coupled to said GPS receiver means for continuously storing said data parameters at time spaced intervals and calculating 2.sup.nd order motion path coefficients for transmission in time spaced data packets and for storing craft identification indicia and for storing aircraft operating parameters and limitations;

digital transmission means coupled to said CPU means for transmitting said time spaced data packets containing the aircraft identification indicia, the unique message type identification, the motion path coefficients, and the time data in digital format to remote receiver means;

digital receiver means coupled to said CPU means for receiving and storing said time spaced data packets containing the identification indicia, the unique message type identification, motion path coefficients, and the time data in digital format from remote transmitter means;

said CPU means having programming instructions so as to be responsive to said data parameters for calculating collision potential between said aircraft and remote object using aircraft motion path data and data received from remote transmitter means; and

Audio means coupled to said CPU means in said craft for notification to aircraft operator of potential collision situation and also evasive instructions.

11. A communication system for determining the position of moveable craft and stationary objects relative to the earth's surface where there is a common referenced multi dimensional position determining system in operation comprising:

position determining means in said movable craft for determining data parameters of position, velocity, acceleration, and time of said craft from the common positioning system;

CPU means in said craft coupled to said position determining means for continuously storing said data parameters at time spaced intervals and calculating 2.sup.nd order motion path coefficients for transmission in time spaced data packets and for storing craft identification indicia and for storing craft operating parameters and limitations;

digital transmission means coupled to said CPU means for transmitting said time spaced data packets containing the craft identification indicia, the unique message type identification, the motion path coefficients, and the time data in digital format to remote receiver means;

digital receiver means coupled to said CPU means for receiving and storing said time spaced data packets containing the identification indicia, the unique message type identification, motion path coefficients, and the time data in digital format from remote transmitter means;

Audio means coupled to said CPU means in said craft for notification to craft operator of collision potential and/or evasive maneuver instructions;

Visual display means coupled to said CPU means in said craft for display of one or more remote craft or objects centered about the present craft;

said CPU means having programming instructions so as to be responsive to said position determining means data parameters and data received from one or more remote transmitter means for calculation and audible and or visual display of location and motion path of said remote craft relative to present craft; and

operator input means coupled to said CPU for manual initiation of transmission of said data parameters including craft identification indicia and unique message type identification.

12. A position reporting system for reporting position and path coefficients of moveable craft and stationary object locations relative to the earth's surface where there is a common referenced multi dimensional position determining system in operation comprising:

position determining means in said movable craft for determining data parameters of position, velocity, acceleration, and time of said craft from the positioning system;

CPU means in said craft coupled to said position determining means for continuously storing said data parameters at time spaced intervals and calculating N.sup.th order motion path coefficients for transmission in time spaced data packets and for storing craft identification indicia and for storing craft operating parameters and limitations;

digital transmission means coupled to said CPU means for transmitting said time spaced data packets containing the craft identification indicia, the unique message type identification, the Nth order motion path coefficients, and the time data in digital format to remote receiver means; and

Audio means coupled to said CPU means in said craft for notification to craft operator of collision potential and/or evasive maneuver instructions;

Visual display means coupled to said CPU means in said craft for display of one or more remote craft or object centered about the present craft;

operator input means coupled to said CPU for manual initiation of transmission of said data parameters including craft identification indicia and unique message type identification.

14. A method for preventing a collision between multiple participating objects in three dimensional space where there is a common referenced multi dimensional position determining system in operation, comprising:

position determining means in movable object for determining data parameters of position, velocity, acceleration, and time of said object;

CPU means in said object coupled to said position determining means for continuously storing said data parameters at time spaced intervals and calculating Nth order motion path coefficients in three dimensional axis for transmission in time spaced data packets and for storing object identification indicia and for storing object operating parameters and limitations;

digital transmission means coupled to said CPU means for transmitting said time spaced data packets containing the object identification indicia, the unique message type identification, the object Nth order path coefficients, and the time data in digital format to remote receiver means;

digital receiver means coupled to said CPU means for receiving and storing said time spaced data packets containing the identification indicia, the unique message type identification, Nth order three dimensional object path coefficients, and the time data in digital format from remote transmitter means in movable or stationary object;

said CPU means having programming instructions so as to be responsive to said data parameters for calculating collision potential between said aircraft and remote object using aircraft motion path data and data received from remote transmitter means;

Audio means coupled to said CPU means in said object for notification to object operator of collision potential and/or evasive maneuver instructions; and

operator input means coupled to said CPU for manual initiation of transmission of said data parameters including object identification indicia and unique message type identification.